

# CMSC733:Homework 0 Alohomora!

Phase 1

Naveen Mangla  
nmangla@umd.edu

Using 2 Late Days

**Abstract**—A true Edge detection has always been an interest of study, the purpose of the Homework is to implement PB-lite edge detection algorithm using various filter banks, creating texture, brightness and color gradients, and using them to finally finding probability of edges on various pixel. This is necessary due to take in to account as it is not hard to fall into the trap of considering minor edge, say small color change a true edge.

## I. ALGORITHM

The Algorithm can be divided into following steps.

- 1) Applying Filter-Banks (DoG,LeunMalik,Gabor)
- 2) Getting Texton, Brightness and Color Maps using KMeans Cluster
- 3) Finding Gradients for each map
- 4) Combining all together to finally reach on PB-Lite image.

Steps are explained as follows:

### A. Creating Filter Banks

1) *Derivative of Gaussian*: DoG filter bank is simply is gaussian kernal convolved with sobel filter rotated in different directions. Here  $\sigma = 5, 9, 15$  and 16 rotations each Fig.1

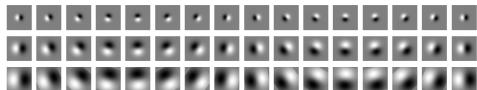


Fig. 1: DoG Filters

2) *Leun-Malik Filters*: Leun-Malik filters involve derivative of a non symmetrical Gaussian (where  $\sigma_x = 3\sigma_y$ ) It involve both single and double differentiation of Gaussian. Here, convolution of a row  $[-1,0,1]$  kernal with gaussian is done to estimate the derivative. Same row kernal is again convoluted to get double derivation estimations. Here  $\sigma = [\sqrt{2}, 2, 2\sqrt{2}, 4]$ . This filter bank also involved a set of laplacian gaussian filters. Fig.2. A total of two sets of filter bank are created, namely LM-Small ( $\sigma = \sigma$ ) and LM-Large ( $\sigma = 3\sigma$ )

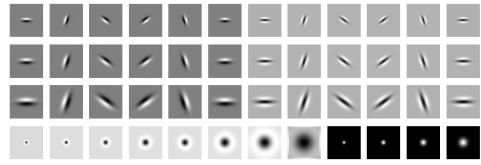


Fig. 2: LM Filters

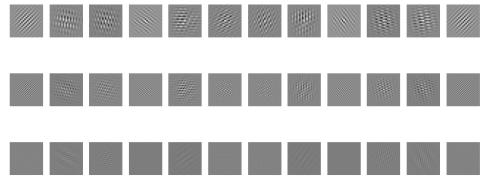


Fig. 3: Gabor Filters

3) *Gabor Filters*: Gabor filters are gaussian kernels modulated with sinusoidal wave. Here 3  $\sigma$  values are considered 5,9 and 15 with 12 rotation each.

### B. Texton,Brightness and Color Maps

Now, We need 3 different kind of maps to describe major edges and getting rid of minor edges. Texton is a texture map, Brightness and Color maps as the name suggest maps the range of brightness and colors. These maps are generated by using K-Means Clusters. The procedure can be seen in Fig. 4 Algorithm is described in Fig.4. Various Texton, Brightness and Color Maps are shown in Fig. 6

### C. Texton,Brightness and Color Gradients

Texton Gradient can be simply described as variation in texture in the image in different directions. Same is true for Brightness and Color gradient as well. Here we are using Half-Disc to achieve these gradient maps. Half disk is simply a binary image of a semi-circle and rotated in

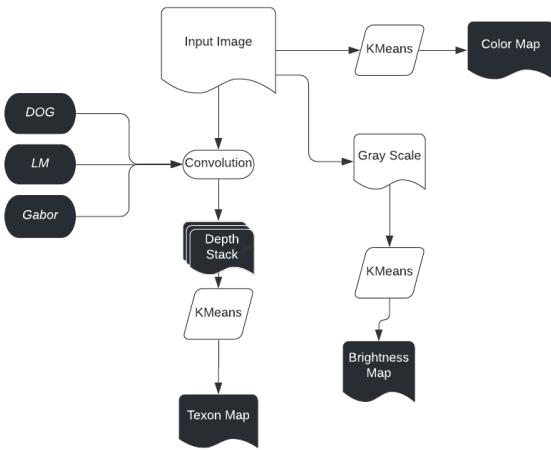


Fig. 4: Algorithm

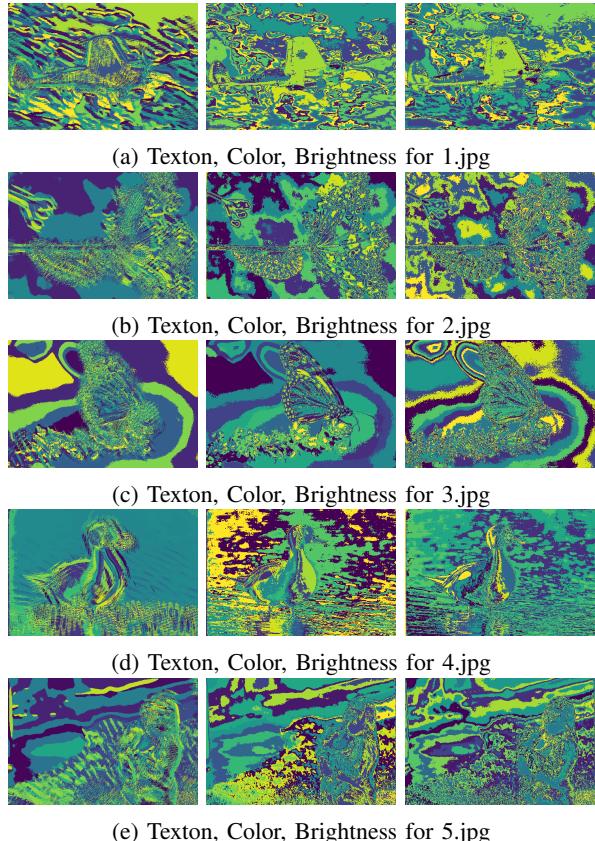


Fig. 5: Texton, Color, Brightness for 1 to 5

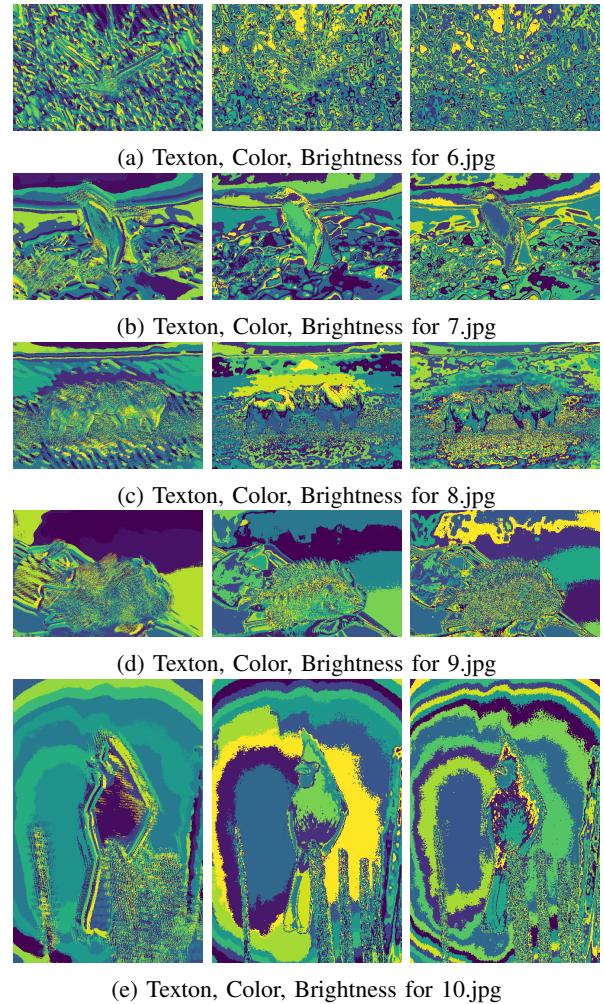


Fig. 6: Texton, Color, Brightness for 6-10

different directions. Here, a simple distance method is used to create half-disk. Since these are in pairs, I chose to make the rotations from  $0^\circ - 180^\circ$ . Disk Mask can be seen in Fig. 7. Map is then masked with pair of disks for every



Fig. 7: Half Disk Masks

available bin. The difference between the left and right mask application is calculated using the  $\chi^2$  distance after binarizing the image. These Gradients can be seen in Fig. 8

#### D. Getting PB-Lite

PB-Lite image is then computed using all three gradients, multiplying with weighted sum of Sobel and Canny Baselines. The comparison can be seen in Fig 9.

These images are created by giving equal weights to both sobel and canny baselines.

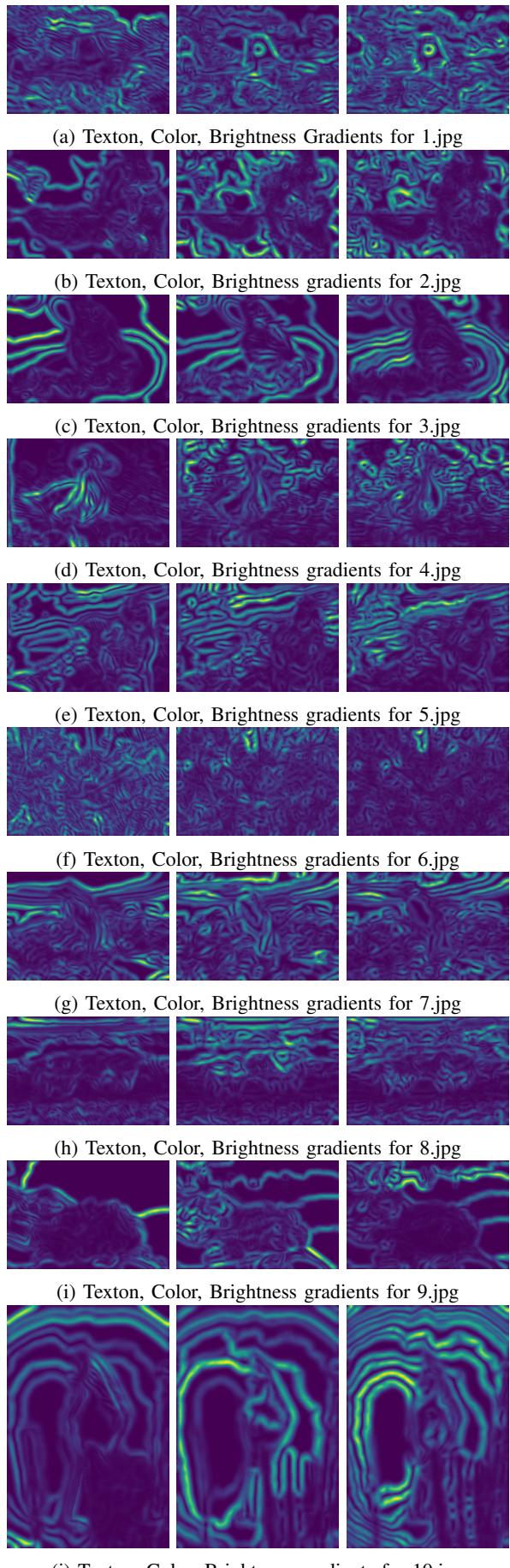


Fig. 8: Texton, Color, Brightness gradients for 10 Images

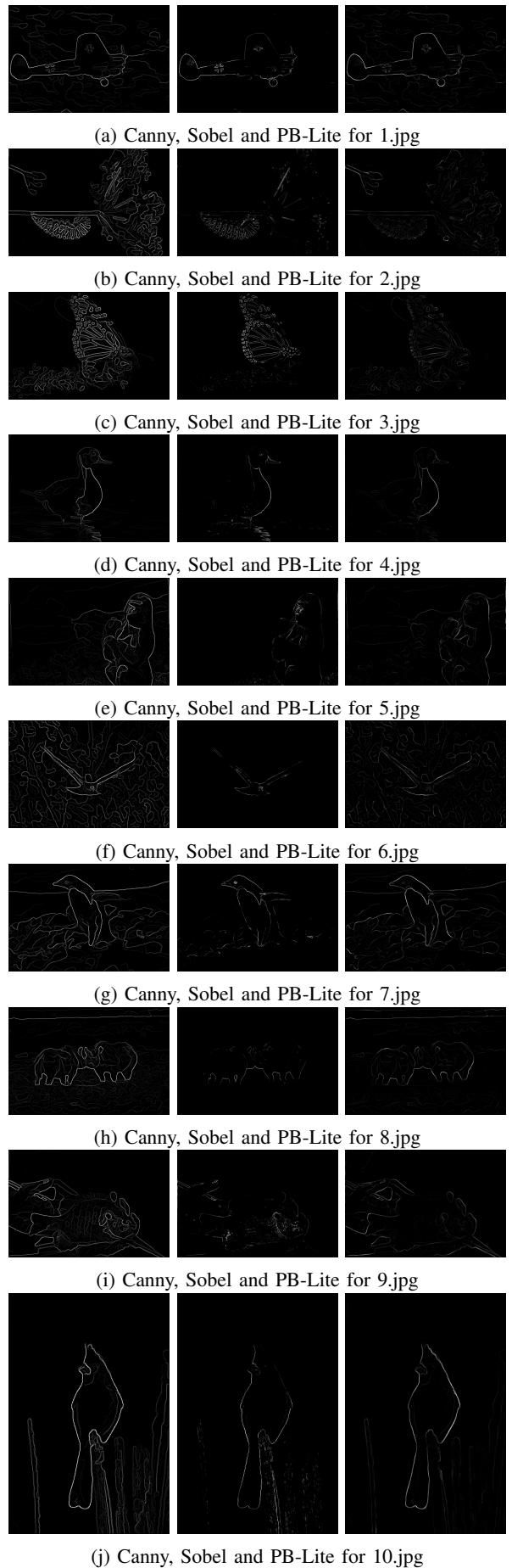


Fig. 9: Canny, Sobel and PB-Lite for 10 Images

## II. ANALYSIS

Pb-Lite image gives the probability of an edge, Since we are using all three brightness, colour and texture gradients, the brightest line is shown where all three changes, in my opinion, this is a major edge of the object, in other words, maximum intensity can be seen at intersection of object and background. Also, Pb-lite image gives us a control on final result by changing values in filter banks and weights of 3 gradient maps. Overall, with a proper choice of parameters for filter banks and size of half-disk, Pb-lite can be a good estimation of edges.

## III. REFERENCES

- 1) [https://en.wikipedia.org/wiki/Gabor\\_filter](https://en.wikipedia.org/wiki/Gabor_filter)
- 2) <https://medium.com/@anujshah/through-the-eyes-of-gabor-filter-17d1fdb3ac97>
- 3) [https://en.wikipedia.org/wiki/Edge\\_detection](https://en.wikipedia.org/wiki/Edge_detection)
- 4) <https://cmsc733.github.io/2022/hw/hw0/>